Transmission of Information by Acoustic Communication along Metal Pathways in Nuclear Facilities

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ABSTRACT:

The proposed research will develop and demonstrate methods for transmission of information in nuclear facilities by acoustic means along existing in-place metal infrastructure (e.g. piping). This innovative means of transmitting information overcomes physics hurdles that beset conventional communication methods (both wired and radio frequency (RF) wireless). This project provides a cross-cutting (applicable to multiple nuclear facility platforms) solution for those areas in the plant where wired or wireless RF communication is not feasible (presence of barriers), not reliable (lack of resilience under accident conditions), or not secure (prone to interception). Use of metallic pathways for transmission of information provides an additional level of protection for securing and protecting data streams by eliminating the broadcasting of RF signals. We will develop the acoustic communication (AC) hardware and network protocols for efficient and secure transfer of data and provide a preliminary experimental demonstration of the AC system prototype in a representative environment. In collaboration with the industry partner, a plan for technology transitioning into industrial setting will be developed.

While the use of wireless RF signals for the transmission and reception of data in nuclear facilities provides, in principle, greater data transfer rate per unit cost, the presence of physical boundaries presents a major challenge to actual implementation. The typical nuclear facility for safety reasons (e.g. confinement of radiation and radionuclides) is heavily partitioned and equipment-packed resulting in transmission paths that are highly attenuating for electromagnetic waves. Primary barriers include a containment building's thick reinforced high-strength concrete walls, which in some plant designs, have liners (steel plates) on both sides. Additional security-related concerns related to use of RF exist because of long distance propagation of RF signal outside of nuclear facility boundaries.

This project brings together national laboratory, university, and nuclear energy industry experts to develop an innovative solution which addresses the requirements of next generation communication systems at nuclear facilities. In the proposed solution, the backbone of the physical layer of the proposed AC system will consist of metal process-fluid conduits. Pipes are omnipresent in a nuclear facility given their role of transferring mass and energy between the outside world and the inner workings of the facility. In our proposal, piping networks will serve as conduits for signals launched as guided acoustic surface waves. Acoustic transducers compatible with harsh operating environment will be developed, along with efficient digital and analog data communication protocols. The AC system to be developed will be compatible with RF wireless networks due to availability of acoustic to RF transducers.